

WHAT IS CLAIMED IS:

1. A method of manufacturing an optical-gate transistor, the optical-gate transistor used for receiving an incident light to generate an electronic current, the method comprising the steps of:

5 forming a silicon substrate;

 forming a boron-phosphide (BP) buffer layer by halide vapor phase epitaxy;

 successively forming a first aluminum-nitride (AlN) layer, a gallium-nitride (GaN) layer, and an n-type AlN layer by metal organic chemical
10 vapor deposition;

 forming a second AlN layer by metal organic chemical vapor deposition;

 forming a source-electrode region and a drain-electrode region by a photolithography and etching method;

15 etching the second AlN layer to form a prism-shaped, light-receiving layer; and

 forming a source electrode and a drain electrode;

 wherein the prism-shaped, light-receiving layer focuses the incident

light to induce electrons in the n-type AlN layer, which further forms the electronic current in the GaN layer.

2. The method according to claim 1, wherein the thickness of the BP buffer layer is about 4000 nm to 5000 nm.

5 3. The method according to claim 1, wherein the second AlN layer is a semi-conducting layer with a cubic lattice having surfaces $\langle 100 \rangle$ and $\langle 111 \rangle$.

10 4. The method according to claim 3, wherein in the step of etching the second AlN layer, the etching speed on the surface $\langle 100 \rangle$ is lower than that on the surface $\langle 111 \rangle$ so that the deposited light-receiving layer has a prism shape.

5. The method according to claim 1, wherein the first AlN layer, the GaN layer, the n-type AlN layer, and the second AlN layer can be any GaN-group material $\text{Al}_x\text{In}_y\text{Ga}_z\text{N}$ where $0 < x+y+z < 1$.

15 6. The method according to claim 1, wherein the electronic current is a high-speed two-dimensional electron gas (2DEG).

7. The method according to claim 6, wherein the n-type AlN layer is a wide band-gap layer, and the GaN layer is a narrow band-gap layer.

8. The method according to claim 7, wherein the incident light induces electrons in the wide band-gap AlN layer to fall into the narrow band-gap GaN

layer, thereby forming the high-speed 2DEG.

9. The method according to claim 1, wherein the n-type AlN layer can also be a p-type AlN layer.

10. The method according to claim 1, wherein after the step of forming
5 the n-type AlN layer, a source-electrode region and a drain-electrode region can be formed by a photolithography and etching method first, and then a selective epitaxy of an AlN material is conducted to form the prism-shaped, light-receiving layer, and the source and the drain electrodes are formed last.

11. The method according to claim 10, wherein in process of the
10 selective epitaxy, the speed of the lattice deposition is controlled to be lower in parallel with deposited layers than on vertical under proper temperature and pressure so that the light-receiving layer can be formed in a prism shape.

12. The method according to claim 1, wherein after the step of forming
the n-type AlN layer, a silicone-dioxide layer can be formed first; then
15 multiple-gate electrode regions are formed by a photolithography and etching method; the source-electrode and the drain-electrode regions are formed continuously; a selective epitaxy of an AlN material is conducted to form multiple prism-shaped, light-receiving layers; afterwards, silicone-dioxide in the gate-electrode regions is etched; and multiple-gate electrodes, the source
20 electrode, and the drain electrode are formed.

13. The method according to claim 12, wherein after the gate-electrode

regions are formed, an AlN layer can be formed first, then a source-electrode region, and a drain-electrode region are formed by a photolithography and etching method; subsequently, AlN materials on the gate-electrode regions are etched, the left part of the AlN layer is further etched to form multiple
5 prism-shaped, light-receiving layers, the silicone-dioxide in the gate-electrode regions is etched, and multiple-gate electrodes, the source electrode, and the drain electrode are formed.

14. An optical-gate transistor, used for receiving an incident light to generate an electronic current, the transistor comprising:

10 a silicon substrate;

a BP buffer layer, formed on the silicon substrate;

a first AlN layer, formed on the BP buffer layer;

a GaN layer, formed on the first AlN layer;

15 a source electrode, an n-type AlN layer, and a drain electrode, which are formed on the GaN layer wherein the n-type AlN layer is positioned between the source and the drain electrodes; and

a prism-shaped, light-receiving layer is formed on the n-type AlN layer.

15. The transistor according to claim 14, wherein the prism-shaped,

light-receiving layer can be made of any GaN-group material $\text{Al}_x\text{In}_y\text{Ga}_z\text{N}$ where $0 < x+y+z < 1$.

16. The transistor according to claim 14, wherein the first AlN layer, the GaN layer, and the n-type AlN layer can also be made of any GaN-group
5 material $\text{Al}_x\text{In}_y\text{Ga}_z\text{N}$ where $0 < x+y+z < 1$.

17. The transistor according to claim 14, wherein the thickness of the BP buffer layer is about 4000 nm to 5000 nm.

18. The transistor according to claim 14, wherein the electronic current is a high-speed 2DEG located in the GaN layer.

10 19. The transistor according to claim 14, wherein the n-type AlN layer can also be a p-type AlN layer.

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